Measuring the Effectiveness of Our Actions to Recover Puget Sound

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Executive Summary

An effectiveness monitoring framework has two parts. First, the actions to restore the ecosystem must be evaluated. Second, the results must be communicated to decision makers as they plan their next round of recovery actions. Many restoration and management actions have been effective in restoring ecosystem components and processes in Puget Sound, while others have not delivered expected results. Much of the evidence supporting these observations is found in technical reports and publications that are not easily accessible. Scientific information needs to be distilled and vetted by regional experts. Once vetted, results of what has worked across various projects can be rolled up to the regional scale to focus the implementation of the Action Agenda and accelerate the recovery of Puget Sound.

For this project we developed four prototypes, that is, preliminary approaches that could be improved or copied, of how to measure and communicate the effectiveness of restoration and management actions called out in the Action Agenda. The four prototypes were 1) reviews of three restoration programs, 2) a statistical meta-analysis of six existing data sets, 3) a matrix of effectiveness monitoring questions and data sources for substrategies in the Action Agenda, and 4) a case study of a monitoring plan to evaluate recovery actions for Island County's Local Integrating Organization (LIO). In the course of developing these prototypes, we were encouraged to find many projects and programs with scientifically derived results about what works to restore Puget Sound; unfortunately, we did not find any central repository or portal that provided access to information about actions, data, results, and costs.

The first prototype distilled information about the effectiveness of three programs by summarizing their recovery actions, outcomes, challenges and costs associated with 1) reducing fecal bacteria to open Samish Basin shellfish beds, 2) planting native vegetation to restore riparian forests in King County, and 3) restoring wetland habitat in Nisqually estuary to increase salmon growth.

The second prototype analyzed existing data to evaluate a variety of projects designed to reduce pollutants, improve water quality and restore habitat. Using statistical meta-analysis, we applied a simple statistic to compare the relative effectiveness of different types of actions. For

example, complete bans on anti-fouling paint reduced toxins in shellfish; in contrast, partial bans did not reduce pesticide detection in streams. As another example, epibenthic taxa were much more responsive to beach restoration than were measures of terrestrial insects or fish. The greatest challenge in the meta-analysis was determining what actions were implemented and when they occurred.

A third prototype articulated questions about the effectiveness of each Substrategy in the Action Agenda and identified data sets to answer these questions.

The fourth prototype demonstrated how an existing monitoring program for status and trends could be modified to evaluate the impact of local Near Term Actions.

Effectiveness monitoring provides the information to measure the success of restoration actions, and in turn guides adaptive management of our restoration strategies. Based on our review of regional literature, we conclude that effectiveness monitoring data and results are approaching a critical mass with the potential to drive adaptive management at the regional scale. As information from diverse programs is distilled and provided at timely decision points, regional recovery will focus and accelerate. The Puget Sound region needs a repository or portal to provide access to effectiveness information and a communication plan to bring the information about effectiveness of actions to decision makers, project sponsors, funders and managers. We provide specific recommendations based on our experience with the four approaches described here.

Introduction

Numerous projects and programs measure the effectiveness of restoration and management actions across Puget Sound. Salmon habitat restoration projects, water quality management to reduce pollutants, and other large habitat restoration projects are described in numerous documents and web pages (Collyard and Onmuwere, 2013; HWS, 2014; Salish Sea Wiki, 2014; TetraTech, 2014). What is less well described is whether there are monitoring data that were collected before and after the restoration and management actions. When data are available, their connection to recovery actions is not always well-documented (but see TetraTech, 2014 for a good example). Barnas and Katz (2010) note this lack of effectiveness information about recovery actions as did Bash and Ryan (2002) when they summarized regional projects and discovered how diverse and diffuse the data sets were. Lack of information on the effectiveness of recovery actions is not limited to Puget Sound. A recent national review by the Government Accountability Office concluded that after implementing 50,000 TMDLs, EPA had little information to determine whether water quality had improved or impairments had been reduced (GAO, 2013).

In the Puget Sound region, we are at a potential tipping point. We currently have enough information about the effectiveness of restoration and management actions that we can begin to connect results across the region and apply them at the regional scale. The goal is to accelerate restoration of Puget Sound by refining our strategies based on the types of projects that are the most effective. Information and results are not well-connected to the planning

stage of new projects, but that work can begin now. Efforts have recently increased to capture information about restoration projects; however, information about the specific actions and when they were implemented is not being captured in any systematic way. When we searched for data and results over the course of this project, we found many sources of effectiveness information, typically in technical reports. The projects were diverse and there is no central repository for effectiveness monitoring results. Our approach was to prototype a few examples of tools that bring together results from the many projects and programs in a way that they can be shared to a broader or different audience.

The purpose of this document is to encourage a regional approach to effectiveness monitoring, that is, to capture, share, and apply learning across our regional programs working to restore the Puget Sound ecosystem. This document describes four prototypes designed to distill effectiveness information about which Strategic Initiatives, Strategies, Substrategies and Near Term Actions in the Action Agenda are working. We collected no new field data; rather, we used existing information. Key findings, next steps, regional value of the project, and how the results connect to the Action Agenda are described below. Details are provided in four additional appendices.

1) Program Reviews – Distilled the actions, outcomes, challenges and costs of three local programs designed to reduce fecal coliform bacteria in Samish Basin, restore native vegetation in King County, and restore wetland habitat in the Nisqually estuary.
2) Statistical Meta-analysis – Starting with original data from published reports, compared the relative effectiveness of specific restoration and management actions using a common statistical framework that measures the ecological condition before and after an action;
3) Action Agenda Effectiveness Monitoring Matrix – Defined questions to assess the effectiveness of actions on the Puget Sound ecosystem and identified data sources to answer the questions for each Substrategy;
4) Case Study of an Existing Monitoring Program – Used Island County's monitoring program to demonstrate how existing data and methods can be adapted to assess the effectiveness of local Near Term Actions.

Role of Effectiveness Monitoring in Adaptive Management

The Puget Sound Partnership (PSP) supports adaptive management as part of its mandate "to coordinate and lead the effort to restore and protect Puget Sound" as defined in statute (RCW 90.71.200). Furthermore, the Partnership and regional entities are accountable for "achieving the outcomes identified in the Action Agenda" (RCW 90.71.350; PSP, 2013a,b). To achieve this mandate, PSP's adaptive management framework supports "iterative decision-making by many entities and builds on explicitly structured interaction among decision-makers, implementers, scientists, and stakeholders to encourage innovation, diffusion, and adaptation" (Redman et al., 2013). To implement adaptive management in practice, PSP adopted the principles of Open Standards for the Practice of Conservation (CMP, 2013) which interprets adaptive management

as a science-informed process to define goals, design solutions, plan and implement actions, and monitor the effects of actions. Learning emerges from the comparison of expected outcomes to actual outcomes; and strategies are adjusted accordingly.

The Action Agenda provides the road map for Puget Sound recovery and is hierarchically arranged in Strategic Initiatives, Strategies, Substrategies and Near Term Actions. Within the context of adaptive management, effectiveness monitoring tells us where management actions are working, which variables respond the fastest, and, specifically to Puget Sound, which actions from the Action Agenda are the most effective. Effectiveness monitoring is the basis of system-wide learning, but not learning for its own sake or to better understand the problem; rather it is learning for the sake of improving the effectiveness of recovery actions (Salzer and Salafsky, 2006; Preskill et al., 2013). Thus, effectiveness monitoring drives adaptive management.

Effectiveness monitoring in other fields such as medicine, psychology, and education, fits under a larger umbrella called evidence based evaluation which makes a distinction between measuring the effectiveness of implementation practices (e.g., planting trees) and outcomes (e.g., increasing salmon populations), recognizing both are important (Patton, 2008). Scientists tend to focus on ultimate outcomes such as biotic or ecosystem endpoints. However, when the Association of Fish and Wildlife Agencies adopted Open Standards for evaluating their population recovery programs, they recognized multiple steps along the road to recovery including measures of how effective the implementation of the action was, whether the actions were effective in reducing pressures, and whether reduction of pressures was effective in restoring habitat and biota (AFWA TWW, 2011, see p. 176). The Puget Sound Action Agenda includes a mix of actions that are focused near the project implementation end of the spectrum as well as longer term outcomes. The effectiveness monitoring matrix for the Action Agenda, developed for this project, evaluated how many substrategies target programmatic actions, e.g., write a report; pressure reduction, e.g., reduce toxics; or recover biota, e.g., open shellfish beds.

Ecosystem restoration is a complex problem, not a linear process. System wide learning about what works, i.e., effectiveness monitoring, is widely recognized as a necessary component for making progress. The emergent literature on collective impact recognizes the complex nature of problems such as ecosystem recovery, poverty, and other social issues. In this context, thought leaders go a step beyond adaptive management, and define collective impact as the commitment of a group of actors from different sectors to a common agenda for solving a complex social problem (FSG, 2014). In order to create lasting solutions to social problems on a large-scale, success depends on five core conditions: common agenda, shared measurement, mutually reinforcing activities, continuous communication, and backbone support (Kania and Kramer, 2013; Preskill et al., 2013). A shared measurement system is key because is provides stakeholders from different agencies a way to evaluate their efforts. Meta-analysis uses a simple statistic that is standardized and comparable across programs. Using this approach, we compared the relative effectiveness of diverse projects. The approach can be easily copied by other entities, a practice identified by Kania and Kramer (2013) of successful programs.

Kania and Kramer (2013) recognize that sharing of evidence-based results across the system is a precursor to success. Shared measures of effectiveness build trust among stakeholders and reinforce mutual objectives. Collective impact is a process for solving problems, not a step-by-step solution. Thus, a core condition for success is continuous learning and communication across the system. We used 2-page fact sheets to foster communication across programs. The people who measured the effectiveness of the program also vetted the fact sheets. In this way, fact sheets and their supporting documentation can be confidently shared by non-experts and referenced by decision makers.

Our project supported learning across the system by creating summary documents (e.g., 2-page fact sheets), sharing and vetting results from the meta-analysis with regional experts and managers (e.g., PSP's Puget Sound Ecosystem Monitoring Program, Environmental Assessment Program at Ecology), and working with Island County decision makers to design monitoring to answer management questions. Participants in regional review groups responded positively to a shared measure of effectiveness and provided insights about why some actions were more effective than others. Grant managers also responded positively to the fact sheets as a tool to evaluate and report effectiveness of diverse programs to reduce fecal coliform in shellfish beds and advise grantees on best practices for restoration projects.

With our emerging ability to better track data and measure outcomes, many government programs are moving to funding models that reward program effectiveness (Leonhardt, 2014). This approach is being implemented across the country and lessons learned from other regions may be relevant for Puget Sound.

Other Regional Effectiveness Monitoring Programs

Several programs in the Puget Sound have been tracking the effectiveness of recovery actions over time or have been recently initiated.

- PSEMP's Stormwater Work Group recently implemented an effectiveness monitoring program for Puget Sound to evaluate which methods are most effective for treating stormwater. Jurisdictions with stormwater discharge permits proposed assessment questions and voted on proposals that are being implemented now.
- WA Department of Ecology's TMDL program tracks progress toward recovery for sites with impaired water quality and has recently designed a management system to track results across projects (Collyard and Onwumere, 2013).
- The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) has developed a monitoring framework to assess the effectiveness of restoration actions and learn which are most effective in restoring ecosystem processes, structures and functions (Brandon et al., 2013). Their goal is to scale up results from individual projects to the regional scale.
- The Salmon Recovery Funding Board established the Reach-Scale Effectiveness Monitoring Program in 2004 that uses standardized protocols to measure the effectiveness of different types of projects (TetraTech, 2014). The Intensively Monitored Watershed (IMW) project was designed to compare changes in salmon abundance as a result of watershed scale

restoration.

- The Bonneville Power Administration has recently proposed an Action Effectiveness Monitoring program for habitat improvement to tributaries (Roni et al., 2013). The project began in 2014 and uses standardized monitoring and reporting to evaluate the effectiveness of hundreds of habitat projects such as fish passage improvement, instream structures, connections of floodplains and channels, and riparian improvement within the Columbia Basin.
- The Columbia Estuary Ecosystem Restoration Program has implemented a regional effectiveness monitoring plan to determine the success of habitat restoration at site, landscape and estuary-wide scales in terms of ecosystem function and juvenile salmon production (Diefenderfer et al., 2013; Johnson et al., 2013).

Recommendations for an Effectiveness Monitoring Framework

Effectiveness monitoring has two relevant parts: 1) testing whether an action was effective in restoring a component of the ecosystem that we care about and 2) reporting to the people who can use that result to make better decisions about how to restore Puget Sound. These people may be project advocates who funded the restoration action, people who are planning a similar project and want to know what worked, or people who are allocating budgets and want to compare proposed projects based on their effectiveness and cost.

To be valuable, the data and information derived from an effectiveness monitoring program needs to be part of a larger social framework that connects the information about action effectiveness to the people who need to know what's working.

An effectiveness monitoring framework is:

- Accessible information about the actions, outcomes, and costs of projects and programs.
- A searchable library or directory of short summary products, e.g., fact sheets, change statistics, summary reports, that distill information from more detailed scientific reports.
- An active communication program to disseminate the results.
- Opportunities for project advocates to find results and recommendations from previous projects that can be used to support project approaches and grant proposals. Examining and building on what's shown to be effective could be a requirement for new proposals.
- A formalized question and answer process, where regional experts vet the questions from decision makers and the answers from scientists. Depending on the context, these could be program staff, academic scientists, or local agency scientists. Scientists shape the questions according to what's possible, and decision makers shape the questions according to what is relevant.

- A distillation and synthesis of data that describes the actions, the changes observed before and after the action, and the factors that impacted the success or failure of the project.
- A way to evaluate the relative effectiveness and cost of various projects using standard and shared measures.

An effectiveness monitoring framework is not:

- Just data. Data collection and analysis are important, but they need to move through a social decision making context. Communication about the data is active, frequent, and structured. Because data are from diverse sources, the results from one group of people must be vetted and compared to results from other groups of people.
- Just data over time. The data collected need to be associated with a recovery action. Collecting data without an action is not effectiveness monitoring, it may be an assessment of status or condition, which is also important.
- Just raw data. Synthesis and distillation are needed to make results accessible.
- Basic research designed to understand how ecosystems work.

What's needed for an effectiveness monitoring framework for Puget Sound:

- A searchable repository for recovery actions that includes summary data collected before and after the actions (or links to their location). (See IES [2014] and OWEB [2014] as examples.)
- A web access point for fact sheets and short reports describing the effectiveness of regional recovery actions.
- A communication plan to identify, vet, and share results to a larger audience.
- A commitment to use effectiveness information to design and propose recovery actions and projects.
- A requirement that program and project managers provide access to project information, including any change statistics.

Results and Key Findings for 4 Effectiveness Monitoring Prototypes

1). Program Reviews, E. Dorfmeier and L. S. Fore

A. Samish Basin: Keeping Shellfish Beds Open,
B. King County Habitat Restoration: Re-establishing Native Forests, and
C. Nisqually Delta: Restoring Ecosystem Function for Salmon

These three program reviews summarize the effectiveness of restoration programs in Samish Bay, King County, and Nisqually Estuary. Although the programs represent results for individual locations, many other groups are performing similar actions. Thus the opportunity is ripe to

share what is known from successful projects to accelerate the success of others so that they can adapt their projects, invest money more effectively and provide early signals on which indicators are more sensitive, and what challenges are anticipated.

Key Findings:

- Samish Bay fecal reduction: By working directly with local landowners to manage their livestock and septic systems, Samish Bay participants successfully reduced contamination in shellfish beds. Closures were reduced and measures of fecals at most sites are lower as a result of farm plans, septic repairs, and changes in how livestock waste is managed.
- King County revegetation: Every year, tens of thousands of trees are planted in Puget Sound to restore habitat. Watering and mulching is expensive (30-50% of total cost), and did not improve survival of plants. Money spent on watering and mulching could be used to plant more trees.
- Nisqually estuary restoration: When levees were removed to create estuary habitat, fish and birds took advantage of the new habitat immediately. The challenge remains to manage the system so that enough sediment is retained to continue forming more habitat.

To communicate these results, the authors worked with C. Cochrane, J. Bridgman, and A. Lawver (PSP Communication Team) to create 2-page fact sheets for each program that highlight the actions, outcomes, challenges, and costs of these successful programs to share with regional partners. A longer narrative of about 10 pages provides background, additional data and interpretation, and links to resources that were used to create the 2-page fact sheets. The original authors vetted the products to ensure the accuracy of the summary products.

Next steps: The summaries were derived from hundreds of pages of reports, web pages, and personal communications. Results from similar projects that the team did not review may be relevant to the interpretation of what we found; therefore, the summaries need to be vetted by appropriate PSEMP work groups and then circulated to regional planners and funders.

Regional Value: Every year, funders provide money to implement projects to restore shellfish beds, restore estuarine habitat and restore trees to riparian areas. Funders and implementers can accelerate the success of current and future projects by sharing what earlier projects have learned. This is a key role of a backbone organization, to communicate which methods are most effective.

Connection to Action Agenda: Samish Bay results inform:

- The Strategic Initiative to recover shellfish beds,
- Strategy C7 to ensure healthy shellfish and harvest,
- Near Term Actions (NTAs) under Substrategies to increase compliance and enforcement to prevent toxic chemicals and pathogens from entering the Puget Sound (Substrategies C1.1, C1.6, C2.2,), and
- NTAs to implement pollution identification and correction programs (C9.4).

King County results for tree planting inform

- Restoration projects associated with the Substrategies to implement and maintain freshwater and terrestrial restoration projects (A2.2) and their associated NTAs, and
- Implementation of projects from the Puget Sound Acquisition and Restoration Fund (PSAR), many of which install trees.

Nisqually estuary results for tidal wetland restoration inform:

- Strategy B2 to protect and restore nearshore and estuary ecosystems, and
- Substrategy B2.2 in particular to implement prioritized nearshore and estuary restoration projects which include Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP), State Parks and state-owned Nearshore restoration projects, and PSAR projects.

2). Meta-analysis of Puget Sound Monitoring Data, C. Sullivan and L. S. Fore

A key component of collective impact is a shared measure of success. Sullivan and Fore applied a statistical approach to compare the success, or effectiveness, of various projects across Puget Sound. Many projects have collected data to test the effectiveness of restoration and management actions designed to restore Puget Sound. The measures are diverse, from fecal coliform bacteria, to number of invertebrates on the beach, to lesions on fish.

Sullivan and Fore summarized results for six studies that measured the effectiveness of actions at 51 sites to reduce toxics, improve water quality and restore habitat and biota using a statistical method called meta-analysis. Meta-analysis is a quantitative method that uses a simple statistical calculation to compare an indicator, such as the number of unique species in a beach sample, before and after restoration. The before/after change is scaled by the variance to make measurements across projects comparable. This measure of effectiveness, called Cohen's d, is a statistic similar to a *t* value. Effectiveness provides a scaled measure of success (or failure) to evaluate and compare projects.

Key Findings:

Toxics

- A full ban of marine anti-fouling paint was successful in removing this toxin from mussels at sites around the Puget Sound.
- In contrast, partial bans of pesticide did not reduce the number of detections of pesticides in Puget Sound lowland streams.
- The sediment cap in Eagle Harbor decreased toxins in fish and made fish healthier.

Water quality contamination

- Direct contact with individual landowners successfully reduced fecal coliform bacteria in Samish Bay and Liberty Bay.
- TMDL programs successfully reduced nitrogen in lakes.

Nearshore habitat restoration

- Habitat restoration of nearshore beaches was dramatically successful for increasing taxonomic diversity epibenthic invertebrates (e.g., harpacticoids and amphipods), many of which are important prey for forage fish and juvenile salmonids.

Meta-Analysis Approach

- The simple statistical framework allowed us to summarize data collected at dozens of locations and across multiple types of projects and put them on the same graph for comparison.
- Working with the original authors and other technical experts to vet the results promoted conversations about which actions are effective, which measures most responsive, and how to communicate results to a broader audience.
- Finding the reports and data for projects was difficult. The best approach was to know who to ask directly for the data. The type, time, and location of specific actions were not always well documented. Lake Tahoe Regional Planning Authority in their efforts to implement Open Standards also found that information on the effectiveness of stream restoration projects was hard to obtain and often incomplete (2nd Nature, 2010). Habitat Work Schedule is meant to do this, but data are rarely available for before and after the actions.

Next steps: A shared measurement system promotes learning and informs strategic decision making by practitioners, funders and evaluators. An interactive web interface to display the results and invite contributions from other projects would expand this type of learning across the region.

Regional impact: Our goal is to encourage the use of this shared measure of whether projects are successful, i.e., the change statistic of meta-analysis, to report the effectiveness of diverse restoration and management actions around Puget Sound. Staff scientists at Kitsap Public Health District, WA Department of Health, and WA Department of Ecology have asked for information about how to apply this technique to measure the success of their programs.

Connection to Action Agenda: Results for pesticides and toxins inform Strategy C1 to reduce sources of toxic contaminants entering Puget Sound (C1.1, C1.1.5, C1.2.1, C1.6.2). Actions to reduce fecal contamination in shellfish beds and restore nearshore and estuary habitat are noted in Section 1) above.

3). Effectiveness Monitoring Matrix for the Action Agenda by C. Sullivan, L. S. Fore, S. Redman, and K. Dzinbal

The Action Agenda for Puget Sound recovery is hierarchically structured into Categories, Strategies, Substrategies and Near Term Actions (PSP, 2013a). The 2012-2013 Action Agenda was structured as Categories (3 out of 5 relevant to effectiveness monitoring), Strategies (21), Substrategies (74), and Near Term Actions (177). The Substrategies provided the right level of specificity for effectiveness monitoring. Sullivan et al. identified data sources that could answer questions about the effectiveness of action implementation, resulting pressure reduction, and long-term outcomes for restoration of habitat and biota.

Key Findings:

- Of the 74 Substrategies in Categories A, B, and C, all could potentially be evaluated for implementation effectiveness; 48 could be evaluated for pressure reduction, and 34 for ecological outcomes.
- 25 of the Substrategies had data available to address the effectiveness of actions.
- 27 Substrategies need additional information to address effectiveness.
- 13 Substrategies had little or no data available.

Next steps: PSEMP Work Groups might review the effectiveness monitoring matrix and point staff to other data sources to evaluate the effectiveness of actions. Other partners might volunteer, or be funded, to analyze data to evaluate effectiveness of actions in the Action Agenda.

Regional impact: The matrix has not been vetted or reviewed outside of PSP. The matrix could be used to rank monitoring proposals or build closer connections between regional monitoring and recovery actions.

Connection to Action Agenda: This matrix closely followed the structure of the Action Agenda and identified data sources that could measure the impact of actions at the Substrategy level.

4). Effectiveness Monitoring Case Study for Island LIO: Evaluation of Existing Data and Next Steps for Monitoring by H. Harguth and L. S. Fore

Key Findings:

- Island County's current monitoring program emphasizes status and trends monitoring and there is interest in moving toward monitoring the effectiveness of recently adopted Near Term Actions.
- Existing water quality data can be used to design a sensitive and efficient monitoring program and can be applied to salmon recovery goals.
- Water quality has improved at Freeland Park as a result of management actions.
- Island County planners and policy makers would like to replicate the success of the Freeland Park restoration efforts.

Next steps: Island LIO (Local Integrating Organization) will continue working with policy makers to implement Near Term Actions. The Island County monitoring team is leading an effort to develop monitoring plans to answer questions about progress toward Island LIO goals for water quality and Chinook recovery.

Regional impact: A PSP goal is to connect monitoring to actions and evaluate whether local implementation of recovery and management actions is having the desired impact on recovery targets. Their approach can provide a template for other LIOs.

Connection to Action Agenda: Local Integrating Organizations are developing Near Term Actions for their local area. Existing monitoring programs will need to evaluate their capacity to measure the effectiveness of these new priority actions. Connecting monitoring more explicitly

to recovery goals for Island County could provide a template for other watershed programs to assess the effectiveness of their actions.

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